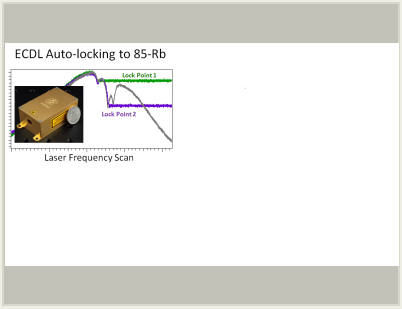
# Cold Atom Laser Module (CALM), Phase I

Completed Technology Project (2017 - 2017)

## Project Introduction

Precision Navigation and Timing (PNT) is a critical resource for government and commercial aerospace. Given the high launch cost and shift toward smaller payloads, reducing the size, weight, and power (SWaP) of space-based navigation systems is a critical need. Atom-interferometric inertial sensors have demonstrated superior performance over conventional inertial devices owing to the intrinsic stability of atomic systems. Central to making cold atom sensors practical is their ability to reliably operate for extended periods without user intervention. Current laser diodes, which are at the heart of atomic sensors, suffer from power degradation and mode hops on timescales incompatible with long term deployment. Because these properties are inherent to the diodes, it is prudent to circumvent these problems with diagnostic protocols aimed at early detection and action. Diodes close to mode hopping can be temporarily taken offline to tune away the mode hop via current and temperature. Diodes with degraded power can be taken offline entirely in favor of a healthy diode. This approach will provide a robust, wavelength-agnostic technique to deliver reliable, long-lived laser sources at atom sensor-relevant wavelengths. AOSense proposes to develop a cold atom laser module (CALM) capable of supporting a broad range of atomic sensors. Phase I will focus on addressing laser source reliability. We will identify and test and candidate laser diodes to identify optimal sources. In parallel, AOSense will develop protocols to identify potential diode failure and seamlessly switch to a healthy diode. Development of the CALM laser module will result in a ruggedized and reliable laser source capable of autonomously driving an atom-based sensor within the space environment. Such an effort would enable space-based applications for atomic sensors such as IMUs, clocks, and magnetometers, opening up significant market opportunities in the defense and commercial sectors.




Cold Atom Laser Module (CALM), Phase I Briefing Chart Image

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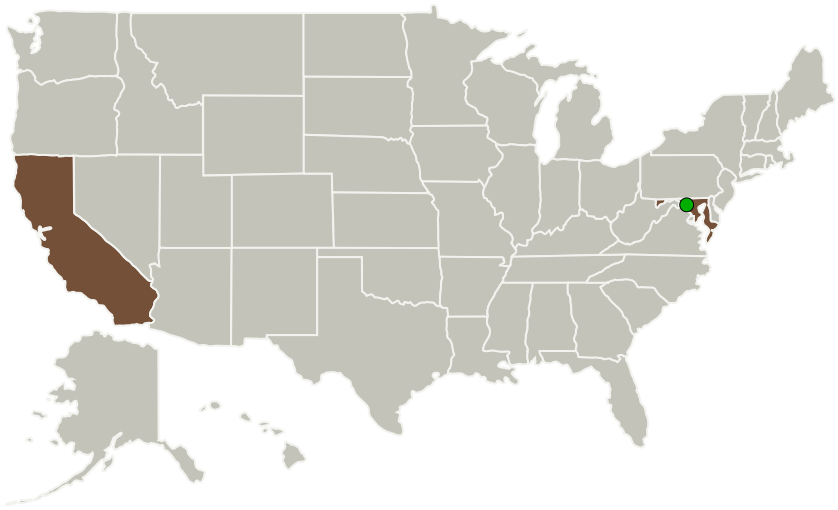
## Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| AOSense, Inc. | Lead Organization | Industry | Sunnyvale, California |
| Goddard Space Flight Center(GSFC) | Supporting Organization | NASA Center | Greenbelt, Maryland |

| Primary U.S. Work Locations | |
|---|---|
| California | Maryland |

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

AOSense, Inc.

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

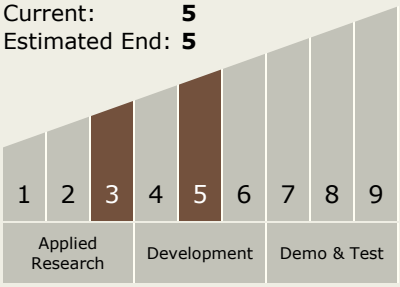
Carlos Torrez

**Principal Investigator:**

Joshua Zirbel

## Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



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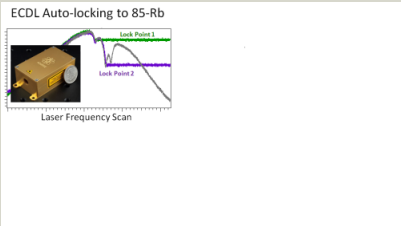
## Images




**Briefing Chart Image**
Cold Atom Laser Module (CALM), Phase I Briefing Chart Image *(https://techport.nasa.gov/image/132717)*

## Technology Areas

**Primary:**

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.4 Network Provided Position, Navigation, and Timing
    - TX05.4.1 Timekeeping and Time Distribution